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DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, D.C. 20314-1000

ETL 1110-3-485

Technical Letter
No. 1110-3-485

15 October 1997

Engineering and Design
FIRE PROTECTION FOR HELICOPTER HANGARS

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1. Purpose. This letter provides criteria relative to the design and construction of fire protection features and systems at Army facilities.
2. **Applicability.** This letter **applies** to all HQUSACE elements and **USACE** commands having military construction and design responsibility.
3. **References.** See Appendix A
4. **Distribution.** Approved for public release; distribution is unlimited.
5. **Objective.** There is currently no design criteria applicable to fire protection for helicopter facilities. Neither the Military Handbook (**MIL-HDBK-1008C**), *Fire Protection for Facilities, Engineering, Design and Construction* nor **NFPA 409, Aircraft Hangars**, provides **specific** fire protection requirements for helicopters. Consequently, various approaches to fire protection for Army helicopter facilities have been taken, resulting in a lack of uniformity in protection features provided Army-wide. This letter seeks to provide a **uniform and** cost-effective approach to helicopter hangar fire protection.
6. **Action.** The guidance included in Appendix B to this technical letter will be used for planning, design and construction of fire protection features and systems for Army facilities.
7. **Implementation.** This technical letter will have special application, as defined in paragraph Sc, ER 1110-345-100.

FOR THE COMMANDER:

2 Appendices
APP A - References
APP B - Fire Protection
For Helicopter Hangars


KISUK CHEUNG, P.E.
Chief, Engineering Division
Directorate of Military Programs

APPENDIX A

REFERENCES

GOVERNMENT PUBLICATIONS

Department of Defense

MIL-HDBK 1008C

Handbook, Fire Protection For Facilities,
Engineering, Design and Construction

Department of the Army

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U.S. Army Corps of Engineers, Engineering
Technical Letter (ETL), Aircraft Hangar Fire
Protection Systems, 26 September 1997

NONGOVERNMENT PUBLICATIONS

International Conference of Building Officials, 5360 Workman Mill Road, Whittier, CA 90601

Uniform Building Code

National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101

NFPA 10

Portable Fire Extinguishers

NFPA 13

Sprinkler Systems

NFPA 20

Centrifugal Fire Pumps

NFPA 24

Private Fire Service Mains and Their Appurtenances

NFPA 70

National Electrical Code

NFPA 72

National Fire Alarm Code

NFPA 90A

Air Conditioning and Ventilating Systems

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NFPA 101

Life Safety Code

NFPA 256

Fire Tests of Roof Systems

NFPA 409

Aircraft Hangars

APPENDIX B

FIRE PROTECTION FOR HELICOPTER HANGARS

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1. INTRODUCTION

Army helicopters are routinely housed in hangars and similar facilities in order to perform maintenance, make repairs, and provide protection from adverse weather. Because these aircraft are usually fueled, they present a fire potential to the facility and the other valuable helicopters and equipment also contained in it. In order to protect against a possible mishap, various fire protection features and systems are essential. Sound fire protection engineering principles mandate a protection system commensurate with the loss potential. Although the probability of a catastrophic fire event may be low, the severity can be high. To mitigate the loss potential, this ETL establishes requirements for cost-effective construction features and fire protection systems. This ETL recognizes the difference in fire potential presented by helicopters as compared to fixed-wing aircraft and provides an alternative to conventional foam fire protection systems.

2. BACKGROUND

This ETL has been prepared because there are currently no design criteria applicable to fire protection for facilities housing helicopters. Currently-published criteria focus on the hazards and fire potential associated with various sizes of *fixed-wing* aircraft. Attempts have been made by designers to apply the provisions of NFPA 409, *Aircraft Hangars*, to facilities housing helicopters. Unfortunately, NFPA 409 is applicable only to facilities housing fixed-wing aircraft, not helicopters. Thus, in the absence of criteria specifically applicable to helicopter hangars, various approaches to fire protection have been taken. This has resulted in a lack of uniformity of protection features provided for Army helicopter hangars. This ETL specifically addresses the hazards and loss potential posed by helicopters and provides criteria for fire protection features and systems in new Army helicopter hangars as well as in retrofitting existing facilities.

3. GENERAL REQUIREMENTS

3.1 Construction Type. New hangar facilities will be of noncombustible construction (UBC Type I or Type II) in accordance with MIL-HDBK-1008C.

3.2 Exit and Access Requirements. Means of egress from aircraft facilities will comply with NFPA 101, *Life Safety Code*.

3.3 Distance from Other Buildings. Clear space around hangars will be provided to reduce fire exposure between buildings and to assure access to such facilities from all sides. The requirements for clear space separation outlined in NFPA 409, Chapter 2, will apply.

3.4 Fire Area Limitations. Helicopter hangar bay areas will not exceed 5576 m² (60,000 ft²). Where larger areas are required, fire walls having a minimum 3-hour resistance rating will be provided to limit hangar bay fire areas.

3.5 Internal Fire Separations. Walls and ceilings separating helicopter hangar bays from attached, adjoining or contiguous shops, offices, parts storage or similar areas, will have at least 1-hour fire resistive rating with openings protected by listed or approved fire doors having a minimum fire resistance rating of 45 minutes.

3.6 Roofs. Roof coverings will be listed as Class "A" or "B" when tested in accordance with NFPA 256, *Standard Methods of Fire Tests of Roof Coverings*. Where insulated metal deck assemblies are used, such will be equivalent to Factory Mutual Class I.

3.7 Structural Steel Columns. Protection of exposed steel columns is not required.

3.8 Draft Curtains. Draft curtains will be provided to form roof pockets with individual areas not exceeding 1394 m² (15,000 ft²). Draft curtains of non-combustible construction will be tightly fitted to the underside of the roof or ceiling and extend down not less than one-eighth the distance from the underside of the roof to the floor. Where permitted by roof structural framing systems, curtains will be affixed to steel trusses, joists or similar framing. For applications involving sloped roofs, draft curtains should run parallel with the roof slope.

3.9 Interior Finish. All interior finishes will have a Flame Spread Rating of less than 25 and a Smoke Developed Rating of 50 or less.

3.10 Floor Drainage. Floor drainage systems will be provided to limit the spread of fuel to mitigate the fire and explosion hazard from fuel spillage. Systems will be designed using underground piping routed to a safe outside location.

3.10.1 The flow of liquids from helicopter hangar bay areas through wall openings will be prevented by installation of drains, ramps, curbs, or other suitable means.

3.10.2 The slope of the floor in the helicopter hangar bay areas will be a minimum of one-half of one percent. Floors will be sloped in the direction of trench drains located at the main hangar doors or other location as required.

3.10.3 Determination of size of drainage piping will include consideration of the calculated maximum demand of installed fire protection systems.

3.10.4 Oil Separators will be provided for drainage systems serving helicopter hangar bay areas.

3.11 Heating Equipment.

3.11.1 Heating equipment will be in accordance with the applicable provisions of NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*.

3.11.2 No heater employing an open flame or glowing element will be installed in helicopter hangar bay areas.

3.11.3 Heating systems fired with gas, liquid, or solid fuels which serve aircraft maintenance and storage areas will be located in a detached building or in a room separated from the hangar by minimum 1-hour fire-rated construction.

3.12 Electrical Systems.

3.12.1 Electrical services will be installed in accordance with Article 513 of NFPA 70, *National Electrical Code*.

3.12.2 Floor grounding receptacles will be provided for removal of static electrical accumulations on aircraft while aircraft are stored or undergoing servicing inside the facility.

3.13 Fire Protection Systems and Equipment.

3.13.1 Automatic sprinkler protection, consisting of one of the following types of systems, will be provided in helicopter hangar bays in accordance with the requirements specified in this ETL:

- a. Wet-pipe foam-water systems utilizing aqueous film-forming foam (AFFF).
- b. Preaction foam-water systems utilizing AFFF.
- c. Water-only wet-pipe systems utilizing Early Suppression Fast Response (ESFR) sprinklers operating at a minimum discharge pressure of 345 kPa (50 psi).

3.13.2 Conventional automatic sprinkler protection, utilizing water (only) and standard sprinklers, will be provided for offices, shops, storage and similar areas adjoining or adjacent to helicopter hangar bays. Hazard classifications and corresponding sprinkler design requirements will be in accordance with MIL-HDBK-1008C.

3.13.3 Manual fire alarm (evacuation) systems will be provided in accordance with NFPA 72, *National Fire Alarm Code*.

3.13.4 Portable fire extinguishers will be provided in accordance with NFPA 10, *Portable Fire Extinguishers*. Wheeled extinguishers employing potassium bicarbonate dry chemical are generally recommended for helicopter hangar bays because they provide the maximum extinguishing capability for Classes B and C type fires.

4. SPRINKLER PROTECTION FOR HANGAR BAYS

4.1 System Types.

4.1.1 Sprinkler systems will be closed-head type. Deluge (open-head) systems will *not* be used.

4.1.2 Systems will be foam-water type using AFFF unless conditions specified herein can be met to permit water-only wet-pipe systems using ESFR sprinklers.

4.1.3 Although foam-water sprinkler systems using AFFF generally provide optimum effectiveness in combating a combustible or flammable liquid spill fire, water-only systems using ESFR sprinklers are considered to be an acceptable alternative.

4.2 System Selection.

4.2.1. The following guidelines for selecting the type of system to be used in helicopter hangar bays are based upon the presumption that heating systems will be provided where required to preclude freezing of pipes during winter months.

4.2.1.1 In geographic areas having a 99% dry bulb temperature greater than -10 °C (15 °F), wet-pipe sprinkler systems will be used.

4.2.1.2 In geographic areas having a 99% dry bulb temperature between -18 °C (0 °F) and -10 °C (15 °F), either wet-pipe or preaction system may be used. Selection of system type will be based upon local factors that can affect potential for freezing of wet-pipe systems.

4.2.1.3 In geographic areas having a 99% dry bulb temperature of less than -18 °C (0 °F), sprinkler systems will be preaction type using AFFF foam-water solution.

4.3 Foam-Water Sprinkler Systems.

4.3.1 Except as modified herein, foam-water sprinkler systems will comply with applicable provisions of ETL 1110-3-484, *Aircraft Hangar Fire Protection Systems*, for detailed requirements for foam-water sprinkler systems.

4.3.2 Foam-water sprinkler systems will be either wet-pipe or preaction type.

4.3.3 The floor area covered by an individual foam-water sprinkler system in helicopter hangar bays will not exceed 1393 m² (15,000 ft²).

4.3.4 Sprinkler systems will be hydraulically designed to provide a uniform minimum discharge density of 6.52 liters/min/m² (0.16 gpm/ft²) over the hydraulically most demanding 1115 m² (12,000 ft²) of floor area.

4.3.5 The maximum allowable protection area of coverage for a sprinkler will be 12.1 m² (130 ft²).

4.3.6 The distance between sprinklers on branch lines will be limited to not more than 3.66 m (12 ft). The distance between branch lines will be limited to not more than 3.8 m (12.5 ft).

4.3.7 Sprinklers will be quick response upright spray type with a temperature rating of 79 °C (175 °F).

4.3.8 Where foam-water sprinkler systems are supplied from domestic water systems, backflow preventers of the reduced pressure type will be provided to prevent foam solution from contaminating the domestic water system. For most applications, individual backflow preventers will be installed in the fire protection equipment room of the protected facility. For installations where a single water storage tank serves both domestic requirements and fire demands through isolated water distribution systems, backflow preventers may be required in the pump house to preclude foam contamination of the water storage tank.

4.4 Water-Only Sprinkler Systems.

4.4.1 Water-only sprinkler systems may be used only in buildings where the distance from the floor to the underside of the roof or ceiling does not exceed 12.2 m (40 ft) and where the roof or ceiling slope does not exceed 167 millimeters/meter (2 inches per foot).

4.4.2 Water-only sprinkler systems will be wet-pipe.

4.4.3 Water-only sprinkler systems will utilize ESFR sprinklers. No other type sprinkler will be permitted.

4.4.4 The use of ESFR sprinklers in water-only sprinkler systems will comply with all applicable provisions of NFPA 13. This includes, but is not limited to, the provision that permits ESFR sprinklers for use only in buildings with the following types of construction:

- a. Smooth ceiling, joists consisting of steel truss-shaped members, or wood truss shaped members that consist of wood top or bottom chord members not exceeding 102 mm (4 in) in depth with steel tube or bar web.
- b. Wood beams of 102 mm by 102 mm (4 in. by 4 in.) or greater nominal dimension, concrete or steel beams spaced 0.9 to 2.3 m (3.5 to 7.5 ft) on centers and either supported on or framed into girders.
- c. Paragraphs (a) and (b) apply to construction with non-combustible or combustible roof or decks.
- d. Construction with ceiling panels formed by members capable of trapping heat to aid the operation of sprinklers with members spaced greater than 2.3 m (7.5 ft) and limited to a maximum of 27.9 m² (300 ft²) in area.

4.4.5 The floor area covered by an individual water-only sprinkler system in helicopter hangar bays will not exceed 2321 m² (25,000 ft²).

4.5 ESFR Sprinkler System Design Requirements.

4.5.1 Systems will be hydraulically designed to provide a minimum sprinkler operating pressure of 345 kPa (50 psi) for all sprinklers in the design area.

4.5.2 The design area will consist of the hydraulically most demanding thirty (30) sprinklers.

4.5.3 The *maximum* allowable protection area of coverage for a sprinkler will be 9.3 m² (100 ft²). The *minimum* allowable protection area of coverage for a sprinkler will be not less than 24.4 m² (80 ft²).

4.5.4 The *maximum* distance between ESFR sprinklers on branch lines or between branch lines will be not more than 3.0 m (10 ft) and the *minimum* distance will be not less than 2.4 m (8 ft).

4.5.5 ESFR sprinkler temperature rating will be intermediate with a temperature rating range of 93 °C to 104 °C (200 °F to 220 °F). The maximum ambient temperature at the underside of the roof or ceiling will be at least 10 °C (50 °F) less than the sprinkler temperature rating.

5. FIRE PROTECTION WATER SUPPLY.

5.1 **Water Storage.** Sprinkler and exterior hose demands will be supplied by one or more elevated or ground level storage tanks of sufficient capacity to meet the calculated demands.

Storage tanks may be part of an existing domestic water distribution system or a dedicated fire protection water system.

5.2 Exterior Hose Demand. Where the water supply for the interior sprinkler systems also supplies hydrants for exterior hose demands, a hose allowance of 1893 L/min (500 gpm) will be included in the hydraulic calculations.

5.3 Duration of Supply. The water supply will be capable of supplying the maximum demand for a period of not less than 60 minutes.

5.4 Underground Water Mains. Underground water mains will be installed in accordance with NFPA 24, *Installation of Private Fire Service Mains and Their Appurtenances*.

5.5 Fire Pumps. Fire pumps will be installed in accordance with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*. Vertical shaft turbine pumps will be used where suction lift is required.

5.5.1 Fire pump drivers will be either electric motors or diesel engines. When electric power is economically available from a reliable single power source, or two independent sources in accordance with NFPA 20, pumps will be electric driven only. Where such electrical power supplies are not available, or cannot be provided, fire pumps will be diesel driven.

5.5.2 A minimum of two fire pumps will be provided. All pumps will be considered in meeting the total system demand. An extra pump, as required by NFPA 409, will not be provided.

5.5.3 The maximum fire pump capacity rating will be 2,000 gpm. Pump pressure ratings will be selected so the maximum pressure maintained on the system does not exceed 1035 kPa (150 psi).

5.5.4 A pressure maintenance or jockey pump will be provided for maintain pressure in the fire protection piping system as specified in NFPA 20.

5.5.5 Fire pumps will be arranged for automatic starting upon pressure drop within the fire protection piping system. Where preaction sprinkler systems are provided, fire pumps will also be arranged for automatic starting upon tripping of any automatic water control valve.

6. FIRE PROTECTION SYSTEM DESIGN REQUIREMENTS

6.1 Designer Qualifications. Due to the importance and complexity of the fire protection systems installed in helicopter hangars, it is essential that the design be accomplished by engineers with extensive experience in design of fire protection systems described herein.

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6.2 Technical Center of Expertise (TCX). A TCX for Aircraft Hangar Fire Protection was established to provide technical assistance to those involved in the design, installation and testing of aircraft hangar foam fire suppression systems. On a cost-reimbursable basis, the TCX will provide technical guidance and assistance to designers of hangar fire protection systems. TCX point-of-contact is Ed Lockwood at (540) 665-3919 (voice) and (540) 665-3628 (facsimile). Correspondence should be directed to the TCX as follows:

U.S. Postal Service:

U.S. Army Corps of Engineers
Transatlantic Programs Center
ATTN: CETAC-EC-TM (Lockwood),
P.O. Box 2250
Winchester, Virginia 22604-1450

Federal Express or UPS

U.S. Army Corps of Engineers
Transatlantic Programs Center
ATTN: CETAC-EC-TM (Lockwood)
201 Prince Frederick Drive
Winchester, Virginia 22602

6.3 Design Procedures. The fire protection system design will be accomplished in accordance with applicable provisions of ETL 1110-3-484, *Aircraft Hangar Fire Protection Systems*. The ETL outlines detailed procedures for designing and specifying fire protection systems for hangars. Lessons learned over several years indicate that foam water fire protection systems, such as those included in this ETL, often fail to meet user requirements and comply with applicable design criteria. Also, costly contract modifications have occurred because requirements were not clearly defined. It is therefore essential that project drawings and specifications clearly delineate, in detail, all system requirements. It is not acceptable to defer design considerations for resolution by the contractor during the construction phase of a project.

6.3.1 Design Analysis. A separate "Fire Protection" section will be included in the project design analysis in accordance with MIL-HDBK-1008C. This section will provide a complete record of the basis of design and will include applicable criteria, designer assumptions, calculations, applicable memoranda and catalog data.

6.3.2 Drawings. Project drawings will include separate fire protection drawings designated as "FP" to delineate all aspects of the system. This will include plans showing water storage and pumping facilities, sprinklers, pipe sizes, control panels, alarm initiating and notification devices, and other components of the system. Drawings will include details of water service entry and method of restraint, fire pump and piping configuration, all sprinkler risers and associated equipment.

6.3.3 Specifications. Corps of Engineers Guide Specifications (CEGS) will be used for the fire protection systems addressed in this ETL. These include, but are not limited to, the following:

- a. CEGS-15320, *Fire Pumps*

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- b. CEGS-15330, *Wet Pipe Sprinkler System*
- c. CEGS-15355, *Aqueous-Film Forming Foam (AFFF) Fire Protection System*
- d. CEGS-16721, *Fire Detection and Alarm System*